THE PERCEPTION OF VISUAL FORM.[1]

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The object of the present Study is to record the perceptions set up by simple visual forms shown to the observer upon a background subliminally or liminally different from themselves. We wished to ascertain whether the illusory perception and associative completion of figures, exhibited under these conditions, obeyed any general law; whether constant individual differences could be made out, as between observer and observer; and whether the development of typical figures, as they passed through the stage of subliminal to that of liminal and thence to that of supra-liminal difference from their background, followed any constant course. The problem proved to be more complex than we had supposed, and the results here published are only preliminary.

§ 1. METHOD AND APPARATUS.

The experiments were performed during the academic year 1899–1900. The apparatus used was that devised for another purpose by Leuba,[2] and modified by Whipple.[3]

The apparatus consisted (*a*) of a blackened tube, 50 cm. in length and 4 cm. in diameter. At a distance of 8 cm. before this stood (*b*) a rotating disc, 49 cm. in diameter, in which were cut 12 radial slits (20 cm. long, 10 mm. wide towards the periphery and 15 mm. wide towards the center of the disc) extending to a distance of 2 cm. from the outer edge of the disc. The disc was made of middle-weight junk-board, faced with gray paper. The electric motor which carried the disc was slung between upright wooden guides, in which it had a vertical movement of some 15 cm. The tube pointed through the upper portion (above the axis) of the disc: so that the lower the disc, the greater was the amount of gray interposed between tube and object. At a distance of 150 cm. from the disc was placed (*c*) a standard, carrying a gray card, 15.5 cm. square, upon which was pasted an outline figure of gray (about 7 cm. square, and 8 mm. in width of line). Only outline figures were used, as the limen for solid figures proved to be a good deal higher than that for outlines.[4] The gray of the background was the Milton-Bradley Co.'s neutral gray, no. 1; that of disc and figure was the slightly lighter warm gray, no. 1. The work was done in the dark room, and the necessary illumination produced (*d*) by two

[1] From the Psychological Laboratory of Cornell University.

[2] *Am. Jour. of Psych.*, V, 376.

[3] *Am. Jour. of Psych.*, IX, 569.

[4] This is evidently due to the multiplication of 'lines of difference' in the outline figures. *Cf.* the difficulty with which the place of junction of several lines is perceived in the experiments cited below.

incandescent lamps in the regular 110 v. alternating current circuit. The first lamp, 16 c. p., hung 20 cm. in front of the disc; the second 32 c. p. (ground glass) hung 35 cm. in front of the object-card. Both were shaded on the side towards the observer. The illumination was not absolutely constant from day to day, though it was sensibly constant during an experimental sitting. A large sheet of black cardboard, fitted to the observing tube, cut off the diffused light of the lamps and screened the whole apparatus from the observer.

The method of work was as follows. The disc was placed at its lowest point, so that the difference between figure and background was subliminal. At a "Now!" following a warning "Ready!" the observer looked through tube and disc, fixating the gray card. Five sec. were allowed for observation; the introspective record was then written down. After the disc had been raised 5 mm., the experiment was repeated; and so on. The time required for a single experiment (inclusive of that taken by the observer to draw and describe what he had seen) was 5 to 10 minutes.

We had anticipated that there would be a considerable error of expectation; but the anticipation was not borne out, either by the objective results or by the introspective records. It was so difficult to make out the figure at all, that the observer seemed to surrender himself wholly to the present impression, rather than to look for a modified form of the preceding impression. It need hardly be said that the observers never saw the figures, save under the conditions of the experiment, and that nothing was said to them as to the rightness or wrongness of their interpretations.

The figures employed numbered 71; and these were turned, some through 90° and some through 180°, so that the total number of stimuli was 142. A few were employed but once; the more suggestive were used much oftener, though not so often as to be recognized by the observer. After a long period of practice 300 experiments were taken. In each of these the disc was raised 8 to 30 times, and each of them gave from 5 to 30 different form perceptions.

The observers were seven in number.

The observers were as follows: (1) Miss L. Aldrich, *A*, a psychologically trained observer, alert, and objective in type; (2) Miss J. Cochran, *C*, a trained observer of the subjective type; (3) Miss L. Hempstead, *H*, a partially trained observer, of the objective type, working with full knowledge of the experiment and its aim; (4) Dr. W. B. Lane, *L*, a trained psychologist, of an extremely subjective type, possessed of some general knowledge of the nature of the experiment; (5) Miss M. F. McClure, *M*, a trained observer,—very alert and imaginative, but still of the receptive or objective type; (6) Miss I. G. Robertson, *R*, an untrained observer, objective; and (7) Miss F. M. Winger, *W*, a trained psychologist, with some knowledge of the experiment, not so easily classed as the preceding observers, but perhaps rather subjective than objective in her attitude towards the experiment. In

order of exactness of perception, the observers fall into 5 groups: *A*,—*R*,—*H*, *M*,—*W*, *L*,—*C*.

It does not appear that the type of the observer, or his general attitude towards the experiment, exerted any marked influence upon the experimental results. All that can be said is that the observers who knew nothing of the experiment, and were alert and objective in temperament, showed a somewhat slighter tendency to get a regular progressive series of illusory perceptions, and a much slighter tendency to see figures that bore no resemblance to the stimuli, than did the observers who were more suspicious and subjectively minded, and who knew or guessed something of the character of the experiment. Certain well defined tendencies of interpretation may be traced through all the records.

§ 2. The Various Forms of Illusory Perception.

The results of the experiment, under this heading, may be classified as follows.

A. *Perceptions which Bear a Definite Resemblance to the Stimulus.* Through all the hundreds of examples of these perceptions certain general and unifying principles may be clearly traced. They are:

I. For the more objectively grounded perceptions:

(1) The joining of different parts of a figure, *i. e.*, the formation of a continuous from a discontinuous figure. This joining may be:

(*a*) Of several isolated portions of a figure. This is irregular and rare, occurring most often where the figure is but feebly sensed. It may be the condition of several of the illusions given under B below. See Plate I, Fig. 1 *a a'*.[1]

(*b*) Of opposite end-points of a given line, or of a terminal point and a straight line. This joining occurs very frequently when the added line runs in a direction similar to that of lines of the figure: otherwise it is rare. Pl. I, Figs. 2 *a a'*, 3 *a a'*.

(*c*) Occasionally, of two lines whose junction can be effected by the continuation of a line in a direction parallel to itself. Pl. I, 4 *a a'*.

(*d*) See 2 *b* below.

The joining lines themselves may be:

(i) straight, so that the connection will be accomplished in the shortest possible way. Pl. I, 5 *a a'*.

(ii) a continuation of a given line,—hence taking its direction. Pl. I, 6 *a a'*.

(iii) curved, as if from mere indefiniteness of direction. Pl. I, 1 *b b'*.

[1] The figures in the columns under the simple letters are the figures used as stimuli; those under the same letters accented show the interpretation put upon these figures by the observer.

(iv) of a form, the 'cue' to which is taken from the lines of the figure. Pl. I, 2 *b b'*.

(2) The continuation of lines. The lines of the given figure may be continued:

(*a*) Indefinitely and irregularly, when parts of the figure first begin to be sensed. Pl. I, 3 *b b'*.

(*b*) When by so doing two portions of the figure will be joined to form a more unitary whole. Pl. I, 4 *b b'*.

(*c*) When by the continuation a symmetrical figure will be produced. Pl. I, 5 *b b'*.

(*d*) When the continuation is in a direction similar to that of other lines of the figure. Pl. I, 6 *b b'*.

(3) The rounding of angles. When the angles of a figure first begin to be perceived, they appear round. This may possibly be an example of the joining of two portions of a figure, made possible by the higher liminal value of solid figures: the angles being rather solid than open forms. Very often the impression of roundness persists even after the angularity has been perceived. Pl. I, 1 *c c'*.

(4) The failure to perceive lines. It often happens that complete lines of a figure are not sensed, although the observer is confident that he has seen the whole form, and is ready to conclude the experiment. This tendency is especially marked when the lines are:

(*a*) Short and disconnected. Pl. I, 2 *c c'*.

(*b*) Included lines. Pl. I, 3 *c c'*.

II. For the more subjectively grounded perceptions:

(1) Tendencies affecting the number of lines.

(*a*) The addition of lines.

(i) What seem to be purely subjective lines appear, to a greater or less degree, with all observers, and are included in nearly all outline figures. They occur throughout the whole experiment, though seldom towards the end. They are very fleeting and uncertain. It is unusual for them to persist for more than two observations, or to be at all constant whether for different observers with the same figure or for the same observer and the same figure at different times. The only—and that a dimly defined—underlying principle is that of symmetry. Pl. I, 4 *c c'*.

(ii) Lines which more definitely conform to rule are added when they can be joined to the ends of given lines and run parallel to other lines. Pl. I, 5 *c c'*.

(*b*) Uncertainty in regard to number of lines. Great uncertainty is shown as to the number of lines, especially in those figures in which a definite form or direction of line is repeated. Pl. I, 6 *c c'*, 1 *d d'*.

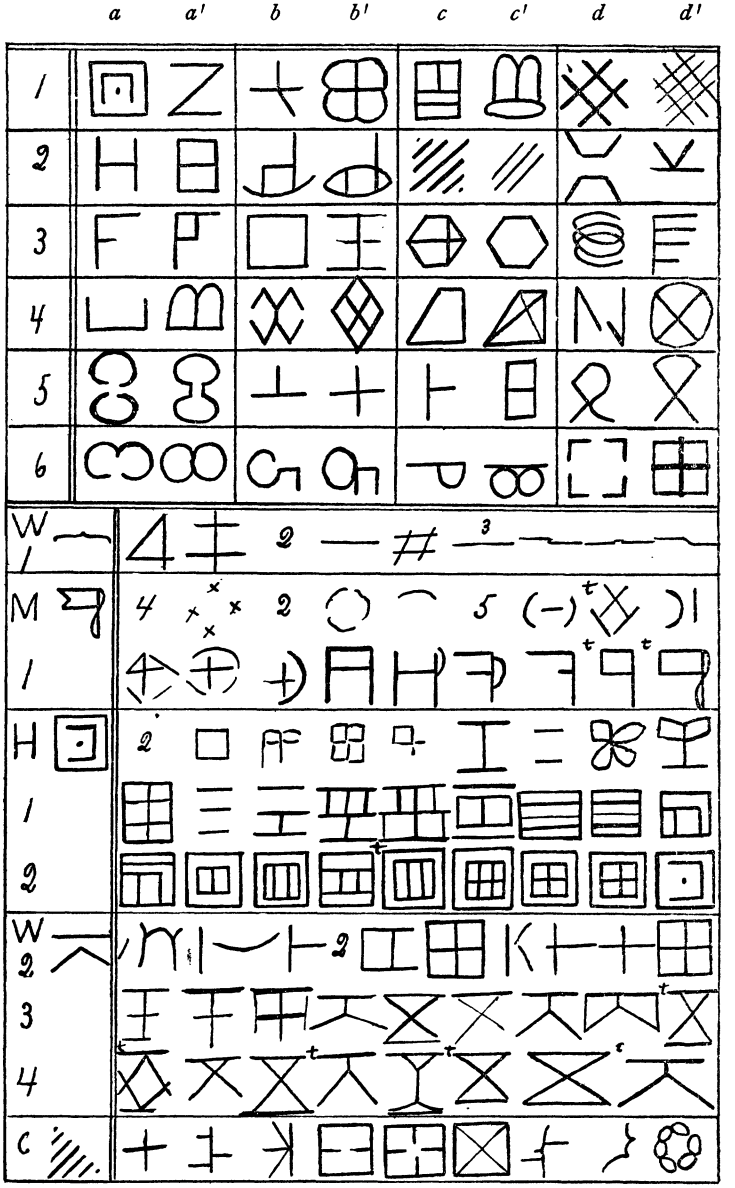

PLATE I.

(2) Those relating to the position of lines. When the figure is as yet very faint, great indefiniteness in respect to position is shown. Pl. I, 2 *d d'*.

(3) Those relating to the form of lines.

(*a*) Lines which are nearly straight are apt to seem straight. Even curved lines, when short or but slightly curved, occasionally appear straight at the beginning of an experiment. Pl. I, 3 *d d'*.

(*b*) Very occasionally, feebly sensed straight lines appear curved. Pl. I, 4 *d d'*.

(*c*) Very often the 'cue' to form is taken from a part of the figure, and applied from this to the whole. Pl. I, 5 *d d'*.

III. Individual Illusions. But one example of an illusion characteristic of only one observer was found. In figures which had a broken outline, *R* saw dark lines crossing the background and cutting the outline where incomplete. Pl. I, 6 *d d'*.

These illusions do not occur singly, but in all manner of combinations, the illusory lines themselves sometimes furnishing a basis for further illusions.

B. *Perceptions which Bear no Traceable Resemblance to the Given Figure.* Toward the beginning of the experiments, and often for some time during their progress, all sorts of figures were seen, which bore no apparent resemblance to the given figure (Pl. I, *M*, *W* 2, *C*).[1] For some observers—for *C* in particular—these figures formed a continuous, ever-changing series, lasting until the real form definitely appeared. For others, they came only occasionally, and often in isolated examples. Not only are the manner in which they appear, and the number of observations during which they remain unchanged, matters of great individual difference, but their number, form and variety are also most characteristic. Some 6 or 7 types of figures can be chosen for each observer, of which all the other forms seen are but modifications. The types are quite different for the different observers.

A distinction was made by the observers between these forms and those which were undoubted modifications of the real

[1] The lower part of Plate I shows the series of forms seen with a given figure. The letters indicate the observers; the numbers below them are inserted simply for convenience of reference. The figures to the right represent the form given, and those still further to the right, extending across the page, are the corresponding series of figures seen. The small *t* indicates that first the one and then the other of the figures on either side was seen during a single observation. The small numbers give the number of times that nothing was seen; the small numbers placed above the figures give the number of times that these were successively seen. *W* 1 and *C* are fragments; the number of figures in the other series has been slightly changed, but the series are none the less typical.

figure. They were spoken of as mere 'impressions.' The line of difference was, however, not sharply drawn; and its drawing did not seem to be conditioned upon any necessary or intrinsic difference of perception. (1) At times, the 'impression' shows decided marks of being influenced by the real figure, while bearing no determinate resemblance to it. It often happened, *e. g.*, in the cases of *L* and *W* (Pl. I, *W* 2, 3), that the impression gradually changed, so as to become the real figure. (2) The impression occurred less often, and was less definite, when a plain gray card was substituted for the stimulus card. When we add to these facts (3) the extreme likelihood, rooted in the nature of the method, that the observer should utilize slight retinal stimulations for the building up of the final geometrical forms, we seem to be forced to the conclusion that the 'impression' and the more objective 'perception' are identical in kind. The apparently contradictory fact, that the impression often changed entirely from one observation to another, is still not incompatible with the theory of chance local excitability of the retina. Experiments are now in progress, whose object is by variation of method to test this hypothesis, and to account (if possible) for the form preferences of the individual observers.

§ 3. The Development of the Form.

The apparatus was so disposed that, for the first few trials, the observer saw no form, or at least had no more than an 'impression.' Presently, portions of the figure began to appear. The form might begin as a mere 'suggession' of something, and then flash suddenly out; or it might develop regularly and gradually. What portion was seen first seems to have been a matter of accident, except that a long line was apt to be perceived earlier than a shorter one. The figure was at first extremely faint, in some cases coming and going so often that 4 or 5 partially different figures were seen during a single observation (Pl. I, *M*, *M* 1, *W* 3, 4). Occasionally, the whole figure would seem to move, or the lines to dance and flicker as their brightness fluctuated.[1] Gradually, in such cases, the figure would become clearer; a definitely marked outline replaced the narrow streaks of light, shading off into the background, which had at first held the attention. The illusions of § 2 were to be noticed from the moment that a form appeared at all. They might last to the very end of the experiment, though more often they disappeared as the figure became more definite. Now and again, an observer reported that he 'felt' an irregularity in the figure, before he was clearly aware of the

[1] G. M. Whipple: *Amer. Jour. of Psych.*, IX, 570.

nature of the irregularity (Pl. I, *W* 1). The simpler figures, and the more regular of the complex figures (those composed of parallel lines), were the more directly and the more correctly perceived; those figures produced the most illusions whose lines offered the most varied foundation for them.

SUMMARY.

(1) In looking at forms liminally different from their background, we are likely to continue lines and to complete figures, under the guidance of the two principles of symmetry and similarity. We are also likely to round angles, and to neglect certain lines altogether.

(2) On the more subjective side, we have but an indefinite idea of the number, form, and position of the component lines. Our perception is, again, guided by the principles of symmetry and similarity.

(3) Each observer has certain habits of illusion, or certain typical modes of associative completion, which persist with modification throughout his records.